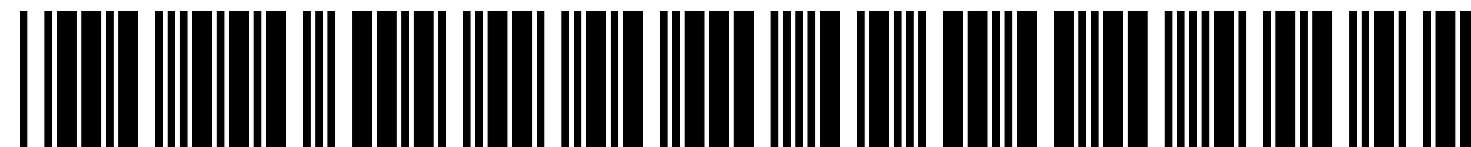


(12) **United States Patent**
Fujii

(10) **Patent No.: US 11,239,063 B2**
(45) **Date of Patent: Feb. 1, 2022**

(54) **VACUUM PROCESSING APPARATUS**

(71) Applicant: **ULVAC, INC.**, Kanagawa (JP)

(72) Inventor: **Yoshinori Fujii**, Kanagawa (JP)

(73) Assignee: **ULVAC, INC.**, Kanagawa (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/973,291**

(22) PCT Filed: **Jul. 23, 2019**

(86) PCT No.: **PCT/JP2019/028821**
§ 371 (c)(1),
(2) Date: **Dec. 8, 2020**

(87) PCT Pub. No.: **WO2020/090164**
PCT Pub. Date: **May 7, 2020**

(65) **Prior Publication Data**

US 2021/0249237 A1 Aug. 12, 2021

(30) **Foreign Application Priority Data**

Oct. 30, 2018 (JP) JP2018-204377

(51) **Int. Cl.**
H01J 37/32 (2006.01)
C23C 14/35 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01J 37/32724*** (2013.01); ***C23C 14/35*** (2013.01); ***C23C 14/50*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC C23C 14/00; C23C 14/34; C23C 14/35; C23C 14/50; C23C 14/541;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,423,192 B1 * 7/2002 Wada C23C 14/046
204/192.12
2005/0184055 A1 8/2005 Natsuhara et al.

FOREIGN PATENT DOCUMENTS

EP 0 679 730 A1 * 2/1995
JP 7-194965 A 8/1995
(Continued)

OTHER PUBLICATIONS

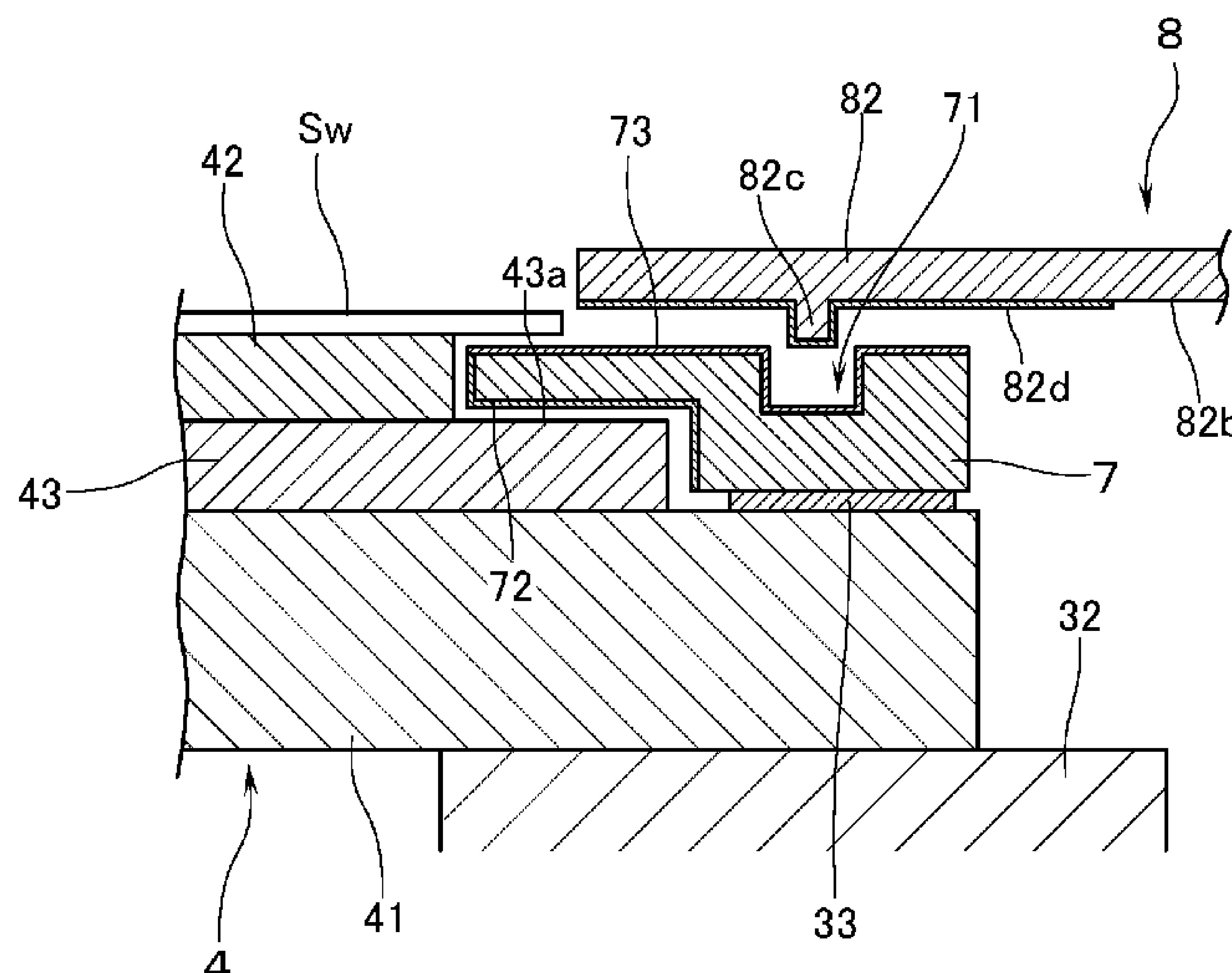
International Search Report for PCT Patent App. No. PCT/JP2019/028821 (dated Sep. 17, 2019) with English language translation.

Primary Examiner — Rodney G McDonald
(74) *Attorney, Agent, or Firm* — Cermak Nakajima & McGowan LLP; Tomoko Nakajima

(57) **ABSTRACT**

A magnet unit for a magnetron sputtering apparatus is disposed above the target has: a yoke made of magnetic material and is disposed to lie opposite to the target; and plural pieces of magnets disposed on a lower surface of the yoke, wherein a leakage magnetic field in which a line passing through a position where the vertical component of the magnetic field becomes zero is closed in an endless manner, is caused to locally act on such a lower space of the target as is positioned between the center of the target and a periphery thereof, the magnet unit being driven for rotation about the center of the target. In a predetermined position of the yoke there is formed a recessed groove in a circumferentially elongated manner along an imaginary circle with the center of the target serving as a center.

4 Claims, 2 Drawing Sheets



(51) **Int. Cl.**
C23C 14/50 (2006.01)
C23C 14/54 (2006.01)

(52) **U.S. Cl.**
CPC ***C23C 14/541*** (2013.01); *H01J 2237/2007* (2013.01); *H01J 2237/332* (2013.01)

(58) **Field of Classification Search**
CPC H01J 37/32724; H01J 2237/2007; H01J 2237/332; H01L 21/203; H01L 21/285
USPC 204/298.11, 298.09; 118/725, 720, 721; 156/345.51, 345.52
See application file for complete search history.

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	2005-158270 A	6/2005
JP	2014-091861 A	5/2014
JP	2015-000994 A	1/2015
JP	2018-095918 A	6/2018

* cited by examiner

FIG.1

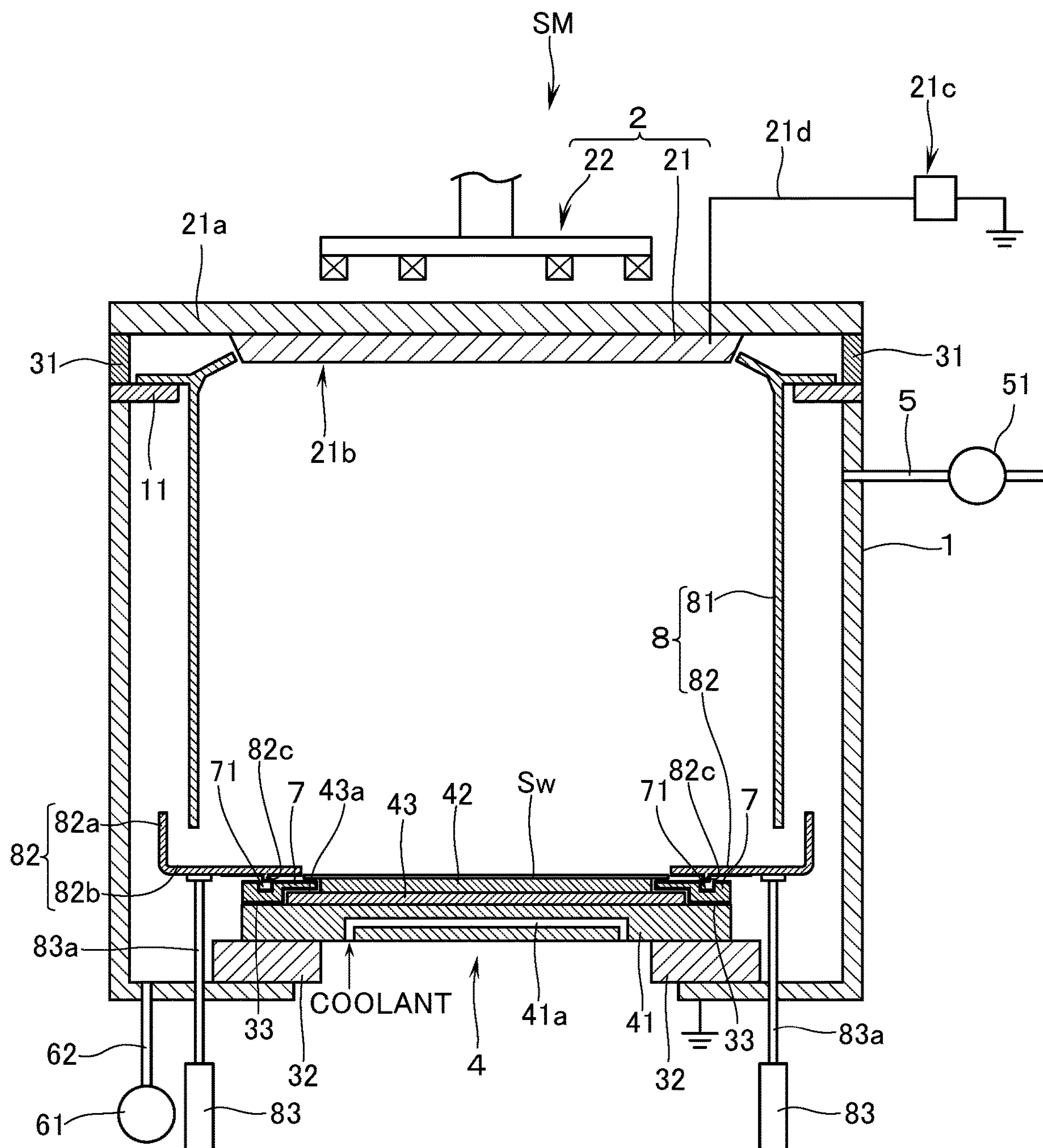
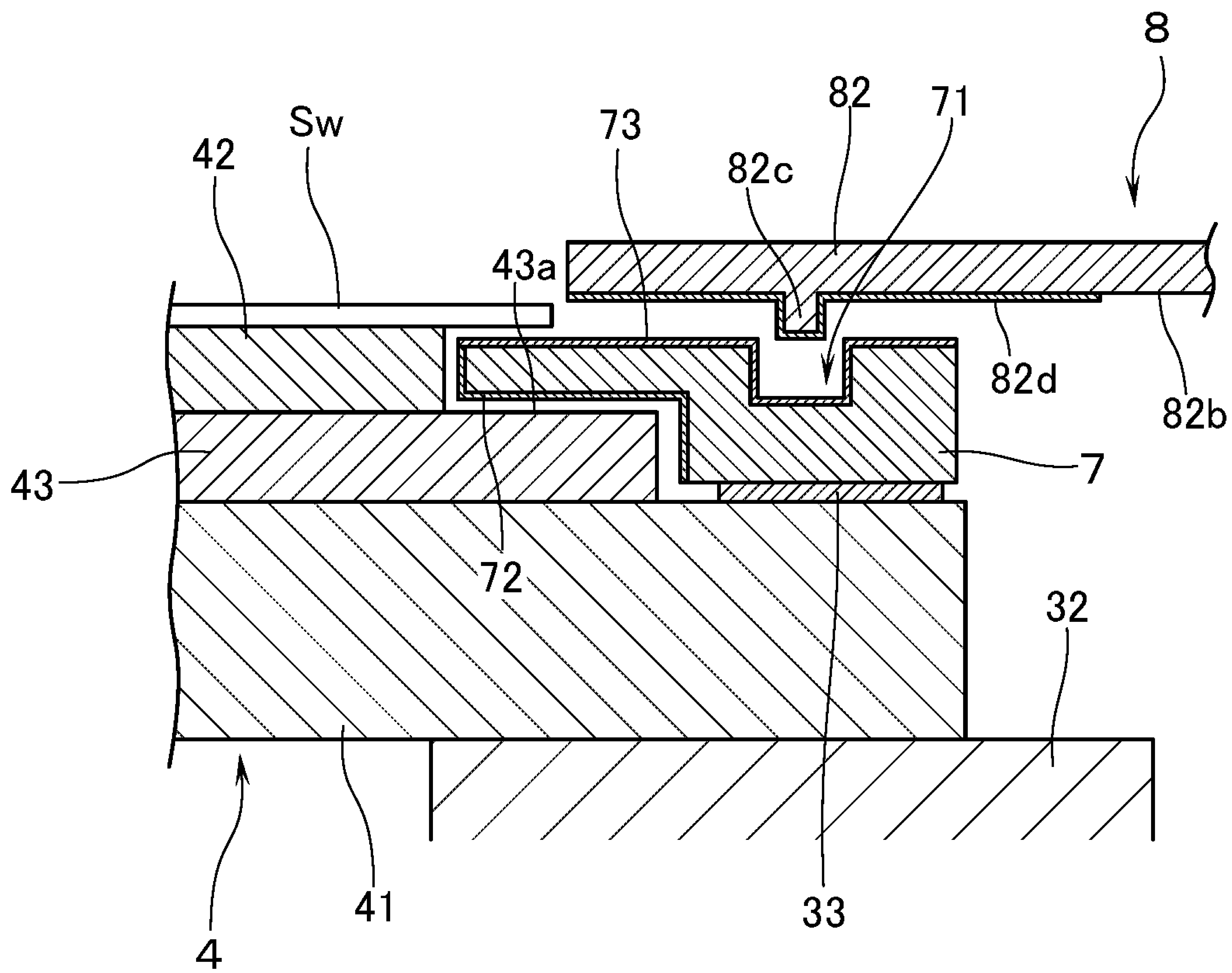


FIG.2



VACUUM PROCESSING APPARATUS

This application is a national phase entry under 35 U.S.C. § 371 of PCT Patent Application No. PCT/JP2019/028821, filed on Jul. 23, 2019, which claims priority under 35 U.S.C. § 119 to Japanese Patent Application No. 2018-204377, filed on Oct. 30, 2018, both of which are incorporated by reference.

TECHNICAL FIELD

The present invention relates to a vacuum processing apparatus having: a vacuum chamber which is capable of forming therein a vacuum atmosphere; and a stage inside the vacuum chamber, on whose stage is disposed a substrate to be processed (hereinafter referred to as a "to-be-processed substrate").

BACKGROUND ART

In a manufacturing step, e.g., of semiconductor devices, there is a step in which a predetermined vacuum processing is performed on a to-be-processed substrate such as a silicon wafer, the vacuum processing being performed inside a vacuum chamber that is capable of forming a vacuum atmosphere. In this kind of vacuum processing there are utilized a film forming apparatus: by a vacuum evaporation method; an ion plating method; a sputtering method or a plasma CVD method, a dry etching apparatus, a vacuum heat treatment apparatus, and the like. For example, the vacuum processing apparatus (sputtering apparatus) for performing film forming by the sputtering method has: a vacuum chamber which is capable of forming a vacuum atmosphere; and a sputtering target which is disposed on an upper part of the vacuum chamber. On a lower part of the vacuum chamber there is provided a stage for disposing thereon a to-be-processed substrate in a manner to lie opposite to the target.

The stage is provided with: a base made of metal and having a contour, e.g., of a cylinder to correspond to the contour of the to-be-processed substrate; and a chuck plate which is disposed on an upper surface of the base and which is smaller than the external dimension of the substrate (see, e.g., patent document 1). During film formation, in case the to-be-processed substrate is controlled to a predetermined temperature range above the room temperature, the following is generally known to the public, i.e.: a hot plate made, e.g., of aluminum nitride is interposed between the base and the chuck plate; also a coolant circulation passage for circulating a coolant inside the base is disposed; and the to-be-processed substrate is controlled to a predetermined temperature range by the heat transmission through the hot plate. By the way, the hot plate can be disposed integrally with the chuck plate.

In forming a predetermined thin film on the to-be-processed substrate by using the above-mentioned sputtering apparatus, in a state in which the to-be-processed substrate is kept electrostatically sucked (adsorbed) by the chuck plate, an inert gas (and a reactive gas) are introduced into the vacuum chamber in a vacuum atmosphere, and electric power having, e.g., a negative electric potential is applied to the target. Depending on the necessity, the hot plate is heated or a coolant is caused to be circulated through the passage provided inside the base so that, by heat transmission through the hot plate, the to-be-processed substrate is controlled to a predetermined temperature which is higher than the room temperature. According to this arrangement, a plasma atmosphere is formed inside the vacuum chamber; such ions of the inert gas as are ionized in the plasma get collided with the target and, consequently, the target gets sputtered; the sputtered particles (substances being generated by the vacuum processing inside the vacuum chamber) splashed from the target get adhered to, and deposited on, the surface of the to-be-processed substrate, whereby a predetermined thin film is formed depending on the kind of target.

When the target is sputtered, sputtered particles get splashed from the surface of the target according to the predetermined cosine law. The sputtered particles will be partly splashed also toward other than the to-be-processed substrate. Therefore, in order to prevent the sputtered particles (substances that are generated by the vacuum processing) from getting adhered to the inner walls of the vacuum chamber, the vacuum chamber is ordinarily provided with: deposition preventing plates made of metal and; around the base and the chuck plate, an annular shield plate called a platen ring which covers such an upper surface portion of the base as is exposed radially outward, while keeping a clearance therebetween.

Here, in case a film is formed on the to-be-processed substrate by the above-mentioned sputtering apparatus under the conditions of heating by the hot plate, it has been found that there are cases where a thin film having desired film quality cannot be formed. Then, as a result of strenuous studies, the inventor of this application has obtained the following findings in: that, depending on the heating temperature of the hot plate, such a surface portion of the platen ring as lies opposite to the hot plate is heated due to radiation from the hot plate, so that various gases (oxygen, water vapor, and the like) are ejected; and that these ejected gases are taken in the thin film, thereby resulting in deterioration of the film quality. These kinds of ejected gases are considered to give bad effect such as possible changes in the etching shape when the to-be-processed substrate is dry-etched by a dry etching apparatus.

PRIOR ART DOCUMENTS

Patent Documents

Patent Document 1: JP-2014-91861-A

SUMMARY OF THE INVENTION

Problems that the Invention is to Solve

This invention has been made based on the above-mentioned finding and has a problem of providing a vacuum processing apparatus as noted below, i.e., in case vacuum processing is performed while controlling, by a hot plate, the to-be-processed substrate disposed on a stage, to a predetermined temperature above the room temperature, there is provided the vacuum processing apparatus which can suppress to the best extent possible an adverse effect on the vacuum processing such, for example, as bringing about the deterioration of the film quality.

Means for Solving the Problems

In order to solve the above-mentioned problem, this invention is a vacuum processing apparatus comprising a vacuum chamber capable of forming therein a vacuum atmosphere, and a stage inside the vacuum chamber, the stage being adapted to dispose thereon a to-be-processed

substrate. The stage has a base and a hot plate disposed on the base so as to enable to heat the to-be-processed substrate. The vacuum processing apparatus further comprises a platen ring and a deposition preventing plate both being made of metal and surrounding the hot plate with a predetermined clearance therebetween. Such a surface portion of the platen ring as lies opposite to the hot plate is made up of (or constituted by) a low-emissivity layer having a lowered emissivity as a result of a surface treatment to a parent metal of the platen ring.

According to this invention, since such a surface portion of the platen ring as lies opposite to the hot plate is made up of a low-emissivity layer, when the platen ring is subjected to vacuum processing under the conditions of heating by the hot plate, the heat rays to be ejected from the hot plate can be reflected. Therefore, the temperature rise of the platen ring itself can be suppressed. As a result, the gas ejection from the platen ring can be suppressed to the best extent possible. For example, there can be prevented from occurring such disadvantages as bringing about the deterioration of the film quality as a result, e.g., of inclusion of the ejected gas into the thin film to be formed. In this invention, the low-emissivity layer may include: one formed by subjecting the parent metal surface itself of the platen ring to a surface treatment by a known method such as mirror finishing, and the like; or one formed as a separate body by subjecting the parent metal surface of the platen ring to a surface treatment by a known method such as thermal spraying and the like. For example, in case the platen ring is made of stainless steel, the platen ring may be subjected to mirror finishing so as to attain the arithmetic average roughness Ra in a range of 0.01 to 2.00, and then the temperature rise of the platen ring may effectively be suppressed. Further, in case the platen ring is said to surround the hot plate with a predetermined clearance, it means that the thermal transmission by radiation becomes dominant between the hot plate and the platen ring. This includes a case in which the hot plate and the platen ring are locally brought into contact with each other due, e.g., to deformation, assembly error, and the like of the hot plate and the platen ring.

Further, in this invention, in case the deposition preventing plate has a portion which lies opposite to the platen ring while keeping a clearance to the platen ring, such a surface portion of the platen ring as lies opposite to the deposition preventing plate is made up of a high-emissivity layer having an emissivity higher than that of the low-emissivity layer. According to this arrangement, the deposition preventing plate can be suppressed from being heated by the radiation from the platen ring. In turn, the gas ejection accompanied by the temperature rise in the deposition preventing plate can be suppressed to the best extent possible, and the occurrence of such a disadvantage as bringing about, e.g., the deterioration of the film quality as a consequence of taking in the ejected gas into the thin film can be all the more prevented. In this case, if such a surface of the portion of the deposition preventing plate as lies opposite to the platen ring has an emissivity equivalent to that of the low-emissivity layer of the platen ring, the deposition preventing plate can advantageously be suppressed from getting heated more effectively.

By the way, in this invention, the emissivity of the low-emissivity layer shall preferably be below 0.3. For example, in case the platen ring and/or the deposition preventing plate is made of stainless steel, the mirror finishing can be applied in a known method to attain an arithmetic average roughness Ra in a range of 0.01 to 2.00 in order to make the emissivity of the surface of the platen ring or the deposition preventing plate below 0.3. Here, the emissivity of the surface means an average emissivity within a range of wavelengths of 2 to 6 μm. In this case, if the emissivity exceeds 0.2, when the hot plate itself is heated, for example, to a predetermined temperature in a range of 300° C. to 500° C., there is a possibility that the heat rays to be ejected from the hot plate cannot effectively be reflected and thus the temperature rise of the platen ring itself cannot be suppressed. Therefore, the emissivity of the low-emissivity layer shall more preferably be below 0.2. In addition, in order to make the emissivity below 0.03, the machining cost will increase beyond the practical level and, therefore, the lower limit of the emissivity of the low-emissivity layer can be set above 0.03. On the other hand, the emissivity of the high-emissivity layer shall preferably be above 0.5. In case the platen ring and/or the deposition preventing plate is made of stainless steel, processing by blasting using the particles within a range of particle diameters, e.g., of 90 to 710 μm, the emissivity of the surface can be made above 0.5.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic sectional view showing a sputtering apparatus according to an embodiment of this invention.

FIG. **2** is a sectional view showing in enlargement a part of FIG. **1**.

MODES FOR CARRYING OUT THE INVENTION

With reference to the drawings, a description will hereinafter be made of an embodiment of a vacuum processing apparatus by citing an example in which, provided that the vacuum processing apparatus is a magnetron type of sputtering apparatus, and that the to-be-processed substrate is a silicon wafer (hereinafter referred to as "substrate Sw"), a predetermined thin film is formed on a surface of the substrate Sw. In the following description, the terms denoting the direction shall be based on the posture of installation of the sputtering apparatus SM as the vacuum processing apparatus as shown in FIG. **1**.

With reference to FIG. **1**, the mark SM denotes a sputtering apparatus according to this embodiment. The sputtering apparatus SM is provided with a vacuum chamber **1**. In an upper opening of the vacuum chamber **1**, a cathode unit **2** is detachably mounted. The cathode unit **2** is made up of a target **21**, and a magnet unit **22** which is disposed above the target **21**. As the target **21** there will be utilized known one of aluminum, copper, titanium, aluminum oxide, and the like. As to the target **21**, in a state in which it is mounted on a backing plate **21***a* and in a posture in which the sputtering surface **21***b* (i.e., the surface to get sputtered) looks downward, the target **21** is mounted on an upper part of the vacuum chamber **1** through an insulating body **31** which is disposed on the upper wall of the vacuum chamber **1** and which also serves the purpose of a vacuum seal.

The target **21** has connected thereto an output **21***d* from a sputtering power supply **21***c* which is constituted by a DC power supply, an AC power supply, and the like depending on the kind of the target. Depending on the kind of the target, it is so arranged that a predetermined power having, e.g., a negative electric potential or a high-frequency power of a predetermined frequency can be supplied to the target **21**. The magnet unit **22** has a known closed magnetic field or cusp magnetic field structure which generates a magnetic field in a space below the sputtering surface **21***b* of the target **21**, collects the ions ionized below the sputtering surface **21***b*

at the time of sputtering so as to efficiently ionize the sputtered particles splashed from the target **21**.

At the bottom of the vacuum chamber **1**, there is disposed a stage **4** in a manner to lie opposite to the target **21**. The stage **4** is made up of; a metal base **41** which is disposed through an insulating body **32** provided at the bottom of the vacuum chamber **1** and which has a cylindrical contour; and a chuck plate **42** which is glued to the upper surface of the base **41**. The chuck plate **42**, which is made, e.g., of aluminum nitride and has an outer diameter which is slightly smaller than the upper surface of the base **41**. Although not explained in particular with illustration, the chuck plate **42** has buried therein electrodes for an electrostatic chuck. It is thus so arranged that, when voltage is applied to the electrodes from an electric power supply (not illustrated), the substrate Sw is electrostatically sucked (adsorbed) to the upper surface of the chuck plate **42**. Further, the base **41** has formed therein a coolant circulation passage **41** which circulates the coolant from a chiller unit (not illustrated). Between the base **41** and the chuck plate **42**, there is interposed a hot plate **43** made, e.g., of aluminum nitride so as to be heated through energization to a predetermined temperature (e.g., 300° C. to 500° C.). In this case, it is also possible to embed a heater inside the chuck plate **42** so as to form the chuck plate **42** and the hot plate **43** integrally. It is thus so arranged that the substrate Sw is controlled within a predetermined temperature range above the room temperature by the heating with the hot plate **43** and by the cooling of the base **41** with the circulation of the coolant through the coolant circulation passage **41***a*.

A side wall of the vacuum chamber **1** has connected thereto a gas pipe **5** for introducing a sputtering gas, and the gas pipe **5** is communicated with a gas source (not illustrated) through a mass flow controller **51**. The sputtering gas includes not only an inert gas such as argon gas and the like that is introduced at the time of forming a plasma in the vacuum chamber **1**, but also a reactive gas such as oxygen gas, nitrogen gas, and the like. Further, a lower wall of the vacuum chamber **1** has connected thereto an exhaust pipe **62** which is in communication with a vacuum pump **61** which is made up of a turbo molecular pump, a rotary pump, and the like. It is thus so arranged that the vacuum chamber **1** is evacuated at a constant speed so as to maintain the vacuum chamber **1** at a predetermined pressure in a state in which the sputtering gas remains introduced at the time of sputtering.

Around the stage **4** inside the vacuum chamber **1**, there is provided, at a clearance therefrom, a platen ring **7** which serves as a deposition preventing plate in a manner to cover the base **41** which is exposed radially outward and, further, an upper surface portion **43***a* of the hot plate **43**. The platen ring **7** is made of a known material such as aluminum oxide, stainless steel and the like, and is disposed around the peripheral portion on the upper surface of the base **41** through an insulating body **33**. Although not explained by illustration, the platen ring **7** is provided, on a lower surface thereof, with a plurality of engaging projections at a circumferential distance from one another and, on an upper surface of the insulating body **33**, is provided with receiving holes which engagingly accept the engaging projections. It is thus so arranged that, when the engaging projections are brought into engagement with the receiving holes, the platen ring **7** is fixed to the insulating body **33**. The upper surface of the platen ring **7** is arranged to be substantially flush with the upper surface of the chuck plate **42**. Further, the vacuum chamber **1** is provided inside thereof with a metallic deposition preventing plate **8** for preventing the sputtered particles, as the substances that are generated by sputtering of the target **21**, from getting adhered to the inner wall surface of the vacuum chamber **1**.

The deposition preventing plate **8** is made up of an upper deposition preventing plate **81** and a lower deposition preventing plate **82**, each being made of a known material such as aluminum oxide, stainless steel and the like. The upper deposition preventing plate **81** has a cylindrical contour and is suspended through an engaging part **11** provided on an upper part of the vacuum chamber **1**. The lower deposition preventing plate **82** has also a cylindrical contour and, on a free end on the radially outside, has formed an erected wall part **82***a* which is erected upward. The lower deposition preventing plate **82** has connected thereto a drive shaft **83***a* from a driving means **83** such as a motor, an air cylinder, and the like, the drive shaft **83***a* extending through a lower wall of the vacuum chamber **1**. By the driving means **83** the lower deposition preventing plate **82** can be moved up and down between: a film forming position in which the film forming is performed by sputtering; and a transport position in which the lower deposition preventing plate **82** is lifted from the film forming position to a predetermined height, thereby handing over a substrate Sw to the stage **4** by means of a vacuum robot (not illustrated). It is so designed that, at the film forming position, the lower end part of the upper deposition preventing plate **81** and the upper end part of the erected wall part **82***a* are overlapped with each other in the vertical direction.

Such a flat part **82***b* of the lower deposition preventing plate **82** as extends at right angles in the vertical direction is sized such that the diametrically (right-and-left direction in FIG. **1**) inside part lies opposite to the platen ring **7**. The flat part **82***b* has formed, e.g., one annular projection **82***c* in a predetermined position on the lower surface. An upper surface of the platen ring **7** has formed therein an annular recessed groove **71** in a manner to correspond to each projection **82***c*. Then, at the film forming position, the projection **82***c* of the flat part **82***b* and the recessed groove **71** of the platen ring **7** form a so-called labyrinth seal. It is thus so arranged that the sputtered particles can be prevented from wrapping (turning) around into the space inside the vacuum chamber **1** that is positioned below the lower deposition preventing plate **82** in the circumference of the substrate Sw. A description will now be made of an example of a method of forming an aluminum film on the surface of the substrate Sw by the above-mentioned sputtering apparatus SM, with the target being defined as aluminum.

After having set in position, inside the vacuum chamber **1**, various kinds of constituting parts such as the target **21**, the platen ring **7**, the deposition preventing plate **8**, and the like, the vacuum pump **61** is operated to evacuate the hermetically sealed vacuum chamber **1**. Then, at the transfer position of the lower deposition preventing plate **82**, a substrate Sw is transferred by a vacuum transfer robot (not illustrated) onto the stage **4**, and the substrate Sw is mounted on the upper surface of the chuck plate **42**. Once the vacuum transfer robot has retreated, the lower deposition preventing plate **82** is moved to the film forming position so as to prevent the sputtered particles from getting adhered to the inner wall of the vacuum chamber **1**. Then, a predetermined voltage is applied from the chuck power supply to the electrodes for the electrostatic chuck. The substrate Sw is electrostatically sucked to the chuck plate **42**. Together with this, the substrate Sw is controlled to a predetermined temperature above the room temperature (e.g., 350° C.) as a result of heating by the hot plate **43** and as a result of cooling

of the substrate Sw by the circulation of cooling medium to the coolant circulation passage **41***a*.

The vacuum chamber **1** is evacuated inside thereof to a predetermined pressure (e.g., 10^{-5} Pa) and also, when the substrate Sw has attained a predetermined temperature, argon gas as a sputtering gas is introduced in a certain amount (e.g., argon partial pressure of 0.5 Pa) through the gas pipe **5**. Together with the above, a predetermined power (e.g., 3 to 50 kW) with negative electric potential is supplied from the sputtering power supply **21***c* to the target **21**. According to these operations, a plasma is formed inside the vacuum chamber **1**, the sputtering surface **21***b* of the target gets sputtered by the ions of the argon gas in the plasma, and the sputtered particles from the target **21** get adhered to, and deposited on, the substrate Sw, thereby forming an aluminum film.

It is to be noted here that, when a film is formed on the substrate Sw under the state of heating by the hot plate **43**, such a surface portion of the platen ring **7** as lies opposite to the hot plate **43** will be heated due to radiation from the hot plate **43**. When the surface portion of the platen ring **7** is heated, such the flat part **82***b* of the lower deposition preventing plate **82** as lies opposite to the platen ring **7** will also be heated. At this time, the sputtered particles (aluminum) will not ordinarily be adhered to the surface portion of the platen ring **7** and to the lower surface of the flat part **82***b*. In other words, they will not be covered by an aluminum film. Therefore, when the surface portion of the platen ring **7** exceeds a predetermined temperature (for example, after having set in position the platen ring **7** and the deposition preventing plate **8** inside the vacuum chamber **1**, the heating temperature at the time of baking for degassing that is performed prior to the film formation) and keeps on increasing in temperature, various residual gases (oxygen, water vapor and the like) remaining on the surface without vacuum evacuation, will be ejected. If these ejected gases are taken into the thin film during the film formation by sputtering, deterioration of the film quality will be incurred. Therefore, such an occurrence must be suppressed to the best extent possible.

In this embodiment, as shown in FIG. **2**, such a surface portion of the platen ring **7** as lies opposite to the hot plate **43** is made up of a low-emissivity layer **72** whose emissivity is below 0.3 as a result of a predetermined surface treatment to the parent material thereof. In concrete, the low-emissivity layer **72** is formed by subjecting the surface of the platen ring **7** to the known mirror-finishing such as polishing or cutting so that the arithmetic average roughness Ra becomes a range of 0.01 to 2.00 relative to the surface of the platen ring **7**. Here, the emissivity denotes an average emissivity within a range of wavelength of 2 to 6 nm. In this case, more preferably the emissivity of the low-emissivity layer **72** shall be below 0.2. If the emissivity exceeds 0.2, when, e.g., the hot plate **43** itself is heated to a predetermined temperature within a range of 300° C. to 500° C., the heat rays to be ejected from the hot plate **43** cannot effectively be reflected, and there is a possibility that the temperature rise in the platen ring **7** itself cannot be suppressed. In addition, in order to reduce the emissivity below 0.03, the machining cost will increase beyond realistic level and, therefore, the lower limit of the emissivity of the low-emissivity layer **72** may be set above 0.03. The low-emissivity layer **72** may be formed at least on such a surface portion of the platen ring **7** as lies opposite to the hot plate **43**. It is, however, also acceptable to form the low-emissivity layer over the entirety of the lower surface of the platen ring **7**. Further, such an upper surface portion of the platen ring **7** as lies opposite to the flat part **82***b* of the lower deposition preventing plate **82** is made up of a high-emissivity layer **73** whose emissivity is above 0.5. In concrete, by using a solid metal, mineral or vegetable abrasive powder (particles) whose particle diameter is in the range of 90 to 710 μm, blasting is applied to an upper surface portion of the platen ring **7**, whereby the high-emissivity layer **73** is formed. The high-emissivity layer **73** may be formed at least in such an upper surface portion of the platen ring **7** as lies opposite to the flat part **82***b* of the lower deposition preventing plate **82** or, alternatively, it may be formed over the entire upper surface of the platen ring **7**. In addition, the lower surface of the flat part **82***b* is also made up of a low-emissivity layer **82***d* whose emissivity is below 0.3, more preferably below 0.2 in a similar manner as the above. The lower limit of the emissivity of the low-emissivity layer **82***d* may also be set, in a similar manner as the above, to above 0.03.

According to the above-mentioned embodiment, since such a surface portion of the platen ring **7** as lies opposite to the hot plate **43** is made up of the low-emissivity layer **72**, when a film is formed under heating conditions by the hot plate **43**, the heat rays to be ejected from the hot plate **43** are reflected. Therefore, the temperature rise of the platen ring **7** itself can be suppressed. As a result, the gas ejection from the platen ring **7** can be suppressed to the best extent possible. For example, the problem of incurring the deterioration of film quality as a result, e.g., of the inclusion of the ejected gases into the thin film, can be prevented. In addition, by constituting such an upper surface portion of the platen ring **7** as lies opposite to the lower deposition preventing plate **82** by the high-emissivity layer **73**, and by constituting the lower surface of the flat part **82***b* by the low-emissivity layer **82***d*, the lower deposition preventing plate **82** can be prevented from being heated by the radiation from the platen ring **7**. Further, the gas ejection accompanied by the temperature rise of the lower deposition preventing plate **82** can be suppressed to the best extent possible. As a result, the possible disadvantage in that the ejected gases will be taken in the thin film, to thereby bring about, e.g., the deterioration in the film quality, can be more positively prevented. Here, an experiment was performed by: using the above-mentioned sputtering apparatus SM; setting the heating temperature by the hot plate **43** to 300° C.; and forming an aluminum film on a plurality of substrates Sw. It has then been confirmed that the temperature of the platen ring **7** could be lowered by about 60° C. and that the temperature of the lower deposition-preventing plate **82** could be lowered by about 30° C.

Descriptions have so far been made of the embodiment of this invention, but this invention shall not be limited to the above-described embodiment. As long as the substance of this invention is not deviated, various modifications are possible. In the above-mentioned embodiment, a description was made based on an example in which the sputtering apparatus SM was used, but as long as the vacuum processing apparatus is provided, inside the vacuum chamber, with a stage having a hot plate thereon and a platen ring around the stage, this invention need not be limited to the above, but can be applied, e.g., also to the dry etching apparatus.

Further, in the above-mentioned embodiment, a description was made of an example in which the low-emissivity layer **72**, **82***d* is formed by subjecting the surface, e.g., of the platen ring **7** to a mirror finishing (surface treatment) so as to obtain the arithmetic average roughness Ra in a range of 0.01 to 2.00. But without being limited to the above, the low-emissivity layer made up of Al, Cu, Au and Pt can also be formed by subjecting the surface, e.g., of the platen ring

7 to a surface treatment such as thermal spraying, film forming and the like. In addition, as the method of mirror finishing, there may be employed singly or in combination known methods such as cutting operation, physical polishing such as buffing and the like and, beyond that, electrolytic polishing and chemical polishing. On the other hand, a description was made of an example in which a high-emissivity layer **73** was formed by performing blasting using solid metal within a range of particle diameters of 90 to 710 μm. However, without being limited thereto, there may be used, e.g., etching or embossing. Otherwise, by subjecting the surface, e.g., of the platen ring **7**, e.g., to the surface treatment such as thermal spraying, film forming and the like, a high-emissivity layer made up of a non-metallic film such as AlTiN, Al_2O_3 and the like or thermal-sprayed film of Ti may be formed.

EXPLANATION OF MARKS

SM	sputtering apparatus (vacuum processing apparatus)				
1	vacuum chamber	4	stage	41	base
43	hot plate	7	platen ring		
72	low-emissivity layer	73	high-emissivity layer		
8	deposition preventing plate				
82	lower deposition preventive plate				
82d	low-emissivity layer				
Sw	substrate (to-be-processed substrate)				

The invention claimed is:

1. A vacuum processing apparatus, comprising;

a vacuum chamber capable of forming therein a vacuum atmosphere, and a stage inside the vacuum chamber, the stage being adapted to dispose thereon a to-be-processed substrate,

the stage having a base and a hot plate disposed on the base so as to enable to heat the to-be-processed substrate; and

a platen ring and a deposition preventing plate both being made of metal and surrounding the hot plate with a predetermined clearance therebetween,

wherein a first surface portion of the platen ring, the first surface portion lying opposite to the hot plate is made up of a low-emissivity layer having a lowered emissivity as a result of a surface treatment to a parent metal of the platen ring,

wherein the deposition preventing plate has a portion which lies opposite to the platen ring while keeping a clearance to the platen ring, and

wherein a second surface portion of the platen ring, the second surface portion lying opposite to the deposition preventing plate, is made up of a high-emissivity layer having an emissivity higher than that of the low-emissivity layer.

2. The vacuum processing apparatus according to claim **1**, wherein a surface of the portion of the deposition preventing plate, the surface lying opposite to the platen ring, has an emissivity equivalent to that of the low-emissivity layer of the platen ring.

3. The vacuum processing apparatus according to claim **1**, wherein the emissivity of the low-emissivity layer is below 0.3.

4. The vacuum processing apparatus according to claim **1**, wherein the emissivity of the high-emissivity layer is above 0.5.

* * * * *